On the Determination of the Orbit of a Planet from Three Observations. By Prof. Cayley. (Abstract.)

The author has proposed to himself to consider from a geometrical point of view the problem of the determination of the Orbit of a Planet from Three Observations. The Orbit is a conic, having the Sun for a focus, and each observation shows that the Planet is at the date thereof in a given line; we have thus a given point or focus, S, and three given lines, say the "rays." The orbit-plane, if known, would, by its intersections with the three rays, determine the three positions of the planet: that is, we should have the focus and three points on the orbit, or, what is the same thing, three radius-vectors from the focus, say a "trivector": geometrically, through three given points and with a given focus, there may be described four conics, but (as explained in the Memoir) only one of these can be the orbit; the orbit is thus determined, and that uniquely, by means of a given trivector. The problem therefore is to find the orbit-plane such that in the orbit determined by means of the trivector the times of passage between the three positions on the orbit may have the observed values, or (what is the same thing) that the orbital areas, each divided by the square root of the *latus rectum*, may have given values. Instead of the orbit-plane, the author considers the orbit-axis (that is, the line normal to the orbit-plane at the point S), or rather the intersection of this line with a sphere about the centre S, say the orbit-pole. To a given position of the orbit-pole there corresponds as above a determinate orbit, and the problem is to find the position of the orbit-pole such that in the orbit belonging thereto the times of passage may have given values, as already mentioned. The required position of the orbit-pole may be obtained as the intersection of two spherical curves, one of them the locus of the orbit-pole when the time of passage between the first and second points on the orbit has its proper given value, the other the locus where the time of passage between the second and third points has its proper given value; and in connexion herewith other isoparametric loci present themselves, for instance, the iseccentric lines, or loci of the orbit-pole such that along each of them the excentricity of the orbit has a given value. The object which the author has proposed to himself in the Memoir is the discussion of the configuration &c. of these loci. He considers, in the first instance, any three given rays whatever, but in the ulterior discussion of the spherical curves, which is carried out numerically, he has confined himself to the case of a particular symmetrical position of the three rays; viz., these are taken to be lines each at an inclination of 60° to a fixed plane through S; and such that their projections on this plane form an equilateral triangle having S for its centre, and that each ray cuts the plane in the mid-point of the corresponding side of the triangle. The results are exhibited graphically by means of the figures called spherograms, each the representation (on the stereographic projection) of the

half-surface of a sphere (not a hemisphere in the ordinary sense of the word, for there is great advantage in employing a different form of boundary)—viz., there is an *e*-spherogram, showing the iseccentric lines; and a T-spherogram showing the isochronic lines.

On the application of Photography as a means of determining the Solar Parallax from the Transit of Venus in 1874. By Richard A. Proctor, B.A.

It is impossible to read Mr. De La Rue's account of the results of careful measurement applied to photographs of the solar eclipses in 1860 and 1868 without recognising that we have in photography, as applied to the approaching Transit of *Venus*, one of the most powerful available means of determining the Sun's distance. Within the last few years, solar photography has made a progress which is very promising in regard to the future achievements of the science as an aid to exact astronomy. So that doubtless, in 1874, astronomers will apply photographic methods to the transit of that year, with even greater success than we should now be prepared to anticipate. It has therefore seemed to me that the photographic observation of the coming transit merits at least as full a preliminary inquiry as either Halley's or Delisle's method of direct observation.

The result of an inquiry directed to this end has led me to the conclusion that photographers of the approaching transit should adopt for their guidance considerations somewhat different than those which have hitherto been chiefly attended to.

It is undoubtedly true, as Mr. De La Rue has pointed out, that the photographer of the transit can readily take a large number of pictures, and by combining these, can ascertain with great accuracy the path of *Venus* across the solar disc. And by comparing the paths thus deduced for different stations a satisfactory estimate can be formed of the solar parallax. I do not wish to suggest any departure from this course of procedure.

On the other hand, it is undoubtedly true, as Major Tennant has remarked, that the greatest effect of parallax will be obtained for any two stations, when both stations, the Earth's centre, and the centre of *Venus*, are in one and the same plane. So far as those two stations are concerned, his remark is just, that it is the position of *Venus* at the instant when the stations are so situated, and not the nearest approach of *Venus* to the Sun's centre, which should be compared. And further, Mr. De La Rue's comment on this, to the effect that his method in reality includes Major Tennant's, is also correct. In fact, there can be no doubt that the position of *Venus* at the particular instant referred to by Major Tennant can be far more exactly ascertained by a reference to the complete path of *Venus* for each station than from any attempt to secure nearly simultaneous photographic records at stations far removed from each other.